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UNIVERSITY OF LISBON
INTERDISCIPLINARY STUDIES
ON SUSTAINABLE ENVIRONMENT AND SEAS

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Life Cycle Assessment

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What is a life cycle assessment?

- Science-based, comparative analysis to understand the **total cradle-to-grave impacts** of a product, good or service;
- Assesses the **inputs** and **outputs** of a product life cycle (including wastes and decommission);
- Addresses impacts such as **costs**, **energy**, **water consumption**, and **emissions**, etc.
- Key features distinct from other environmental assessment tools: analysis from ‘cradle-to-grave’ and the ‘functional unit’.

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Why should I care?

WITH LCA YOU CAN SEE AT ONCE BOTH THE **BIG PICTURE** AND THE **DETAILS**

IDENTIFY **OPPORTUNITIES** TO ENERGY AND WASTE SAVINGS

IDENTIFY COST SAVING OPPORTUNITIES

LCA IS HELPFUL TO **COMPARE ALTERNATIVES** AND **IDENTIFY HOTSPOTS**

LCA IS GLOBALLY RECOGNIZED AND BASED ON **ISO STANDARDS** (ISO 144040-04)

ANSWERS CUSTOMER'S REQUESTS FOR ENVIRONMENTAL AND SOCIAL **CERTIFICATION** (VERY IMPORTANT FOR BIOENERGY)

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What LCA can and cannot answer

1. Is paper, plastic or textile bags the most environmentally friendly option for carrying groceries back from the supermarket?
2. From an environmental point of view should we use bio-fibre composites or steel for the car body?
3. Am I increasing my environmental footprint if I bought a new and more efficient car and scrapped my old one?
4. Are electric cars more environmentally friendly than conventional internal combustion engine cars and what are the important parameters deciding this?
5. Is it more environmentally friendly to do the dishes manually or using a dishwasher?

1. Should taxes on old diesel cars be increased to reduce emissions of particles and thereby reduce hospital spending on treating lung diseases?
2. Do current emissions from a specific factory lead to pollutant concentrations above regulatory thresholds in nearby aquatic ecosystems?
3. Do increasing temperature levels responsible for mass extinction of polar bears?

Cost benefit analysis combined with Health Assessment Studies

Chemical risk assessment

Ecological assessment

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LCA standards and guidelines

1. **International Organization of Standardization (ISO) developed a global standard for LCA framework**
- 4 standards, addressing the principles and framework (ISO 14040), the goal and scope definition (ISO 14041), the life cycle impact assessment (ISO 14042), the life cycle interpretation (ISO 14043) and requirements and guidelines (ISO 14044);

2. **UNEP/SETAC Life Cycle Initiative** evaluates alternative practices and develop recommendations from a scientific point of view

3. **International Life Cycle Data System** cookbook (EU-JCR) - Detailed descriptions and requirements in order to reduce flexibility in choices and to support consistency and quality assurance of LCA results

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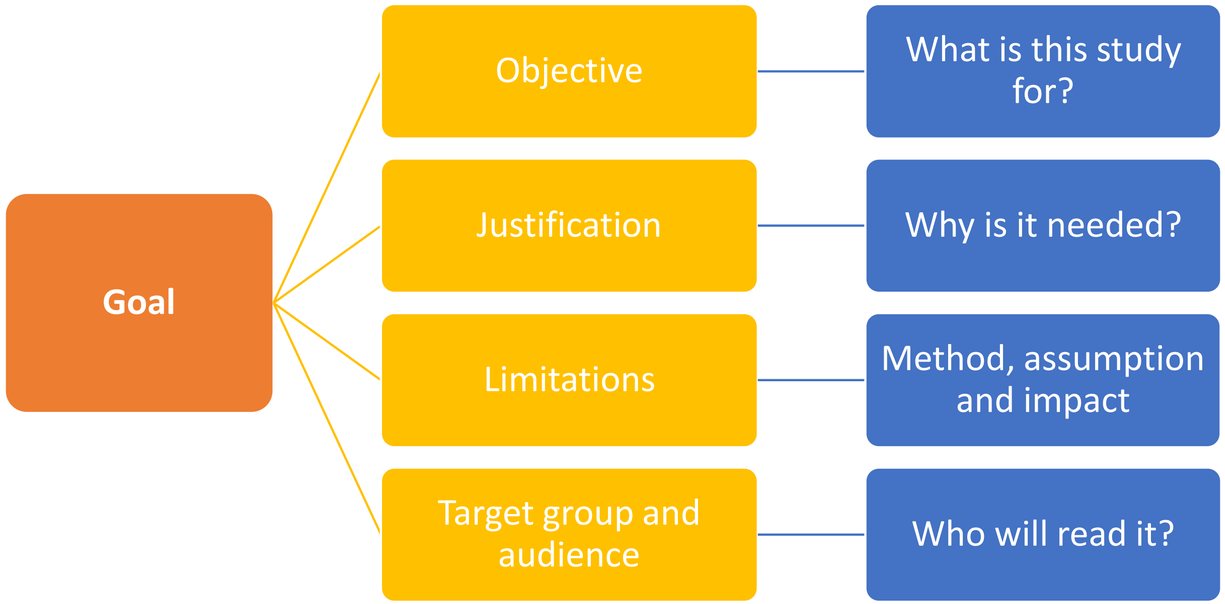
Goal and scope definition

General decisions to set up the study



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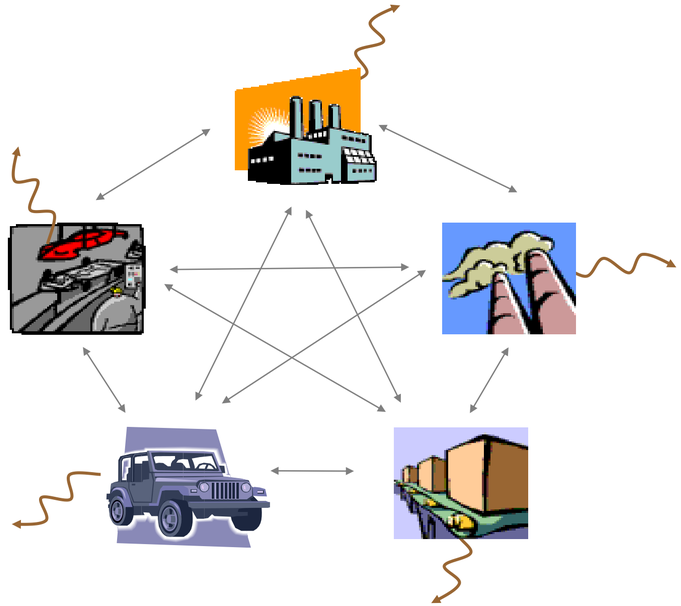
Goal and scope definition

For a given functional unit:

- What are the processes involved?
- What are the resource use and emissions of these processes?
- What are resource use and emissions per functional unit?



Adapted from Hertwich (2011) ('Life-cycle assessment and Environmental Systems Analysis')

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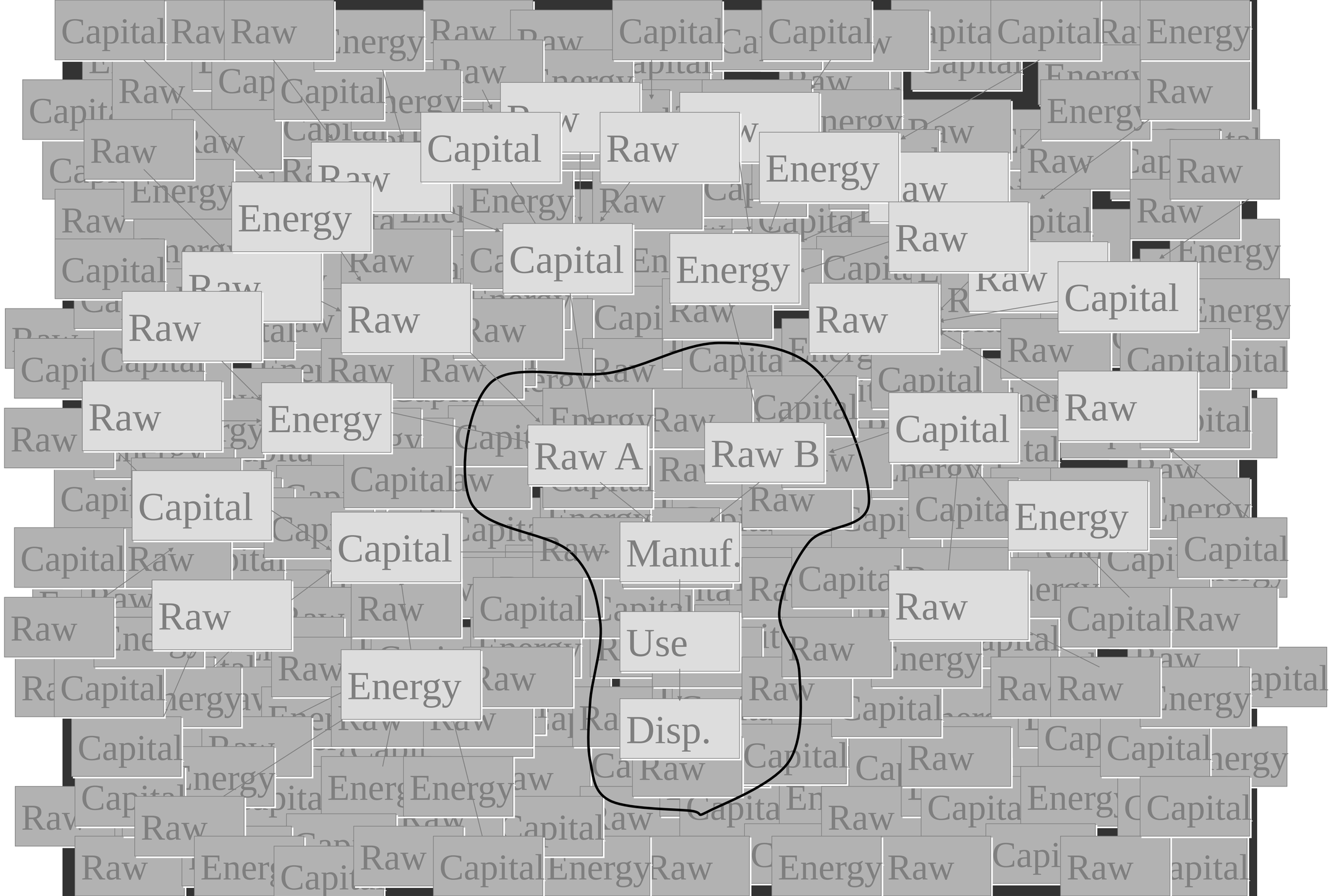
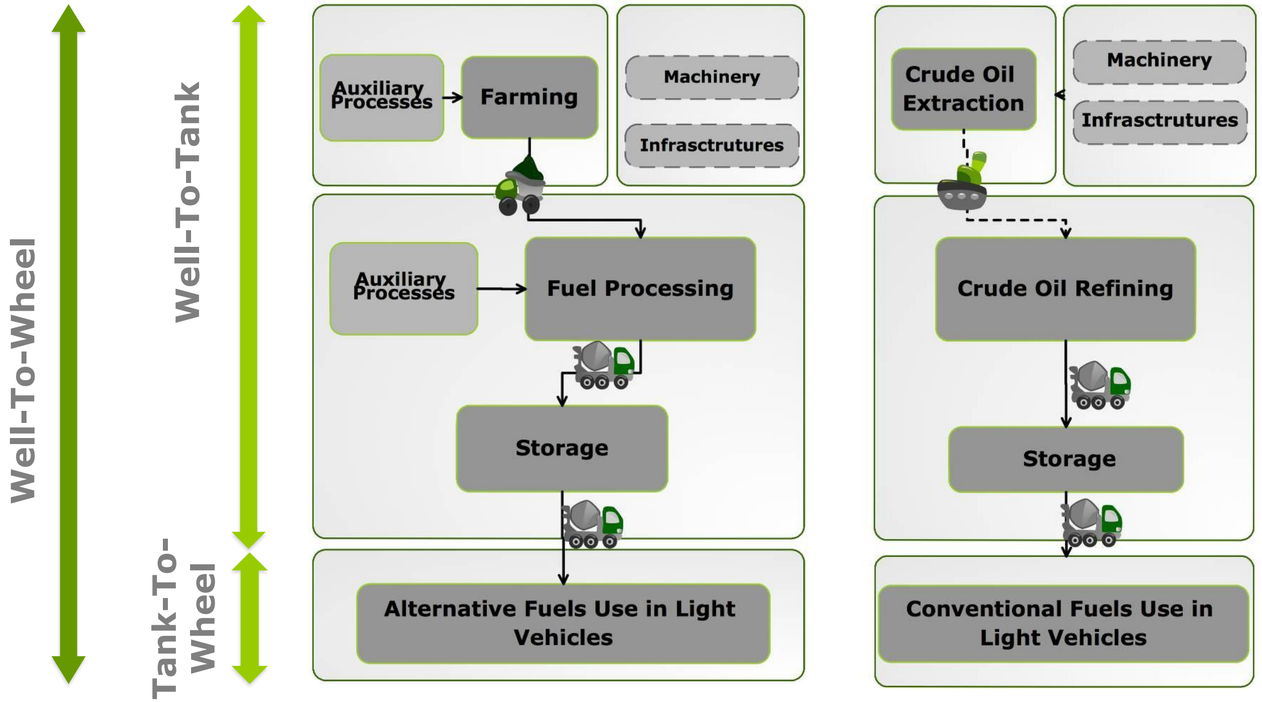

Raw A
Raw B
Manuf.
Use
Disp.

Scope definition

- Example: System boundaries of conventional and alternative fuels



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Scope definition

System boundaries

→ Processes/operations, and the inputs and outputs to be taken into account

→ Resources need not be expended on the quantification of minor or negligible inputs and outputs that will not significantly change the overall conclusions of the study *(cut-off criteria)*

→ **Spatial** coverage (local, regional, national, continental, global)

→ **Temporal** coverage

→ **Technology** coverage (average technology, innovative, BAT, worst-operating unit)

→ **Well-to-Tank, Tank-to-Wheel or Well-to-Wheel**

→ **Cradle-to-Gate, Gate-to-Grave, Cradle-to-Grave**

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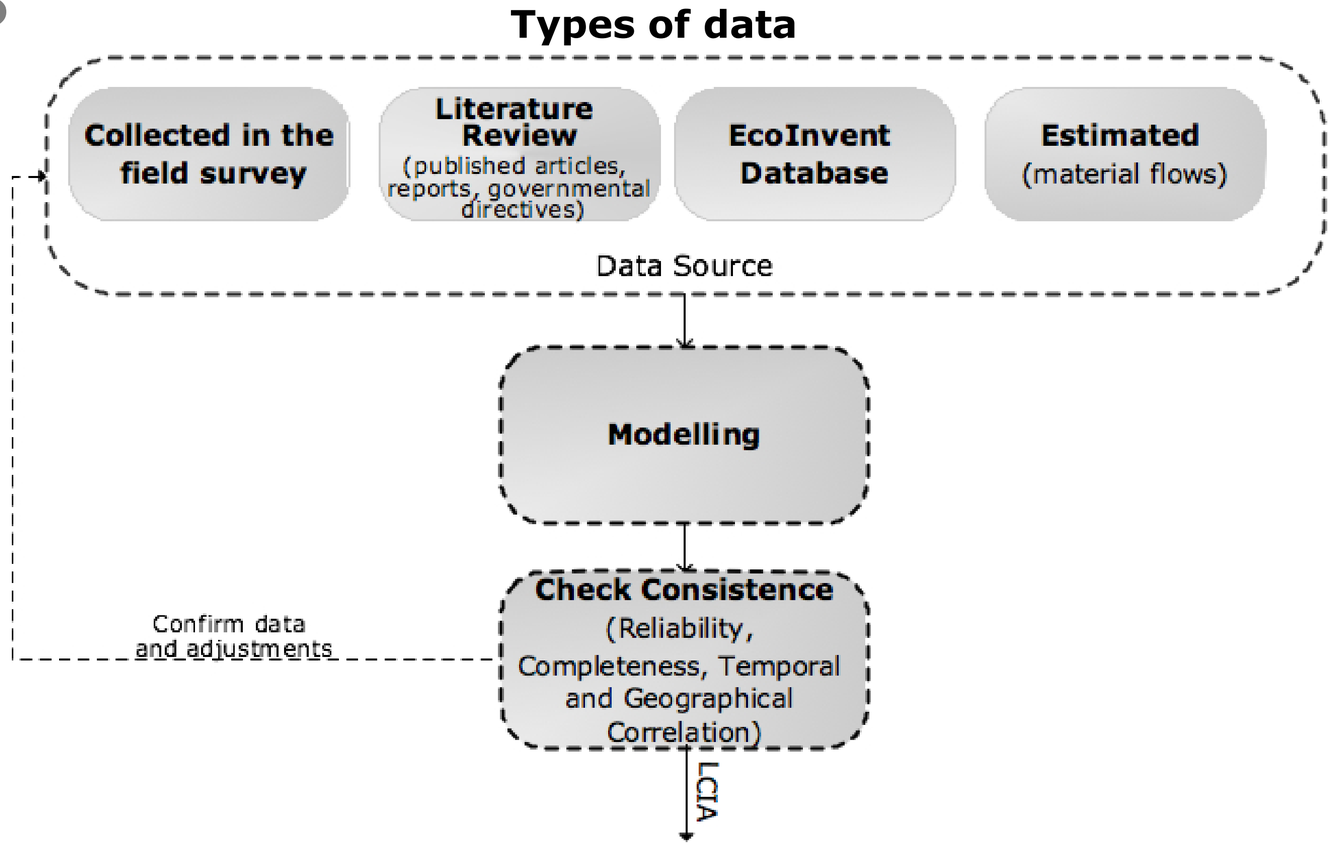
Inventory Analysis



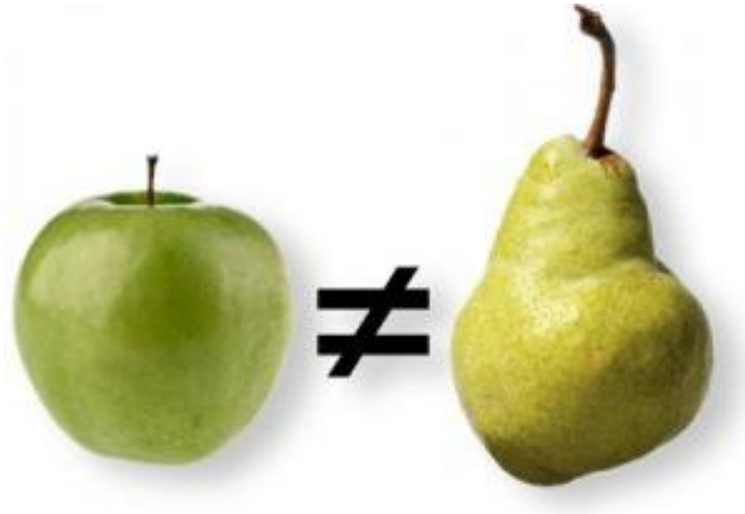
What is the life cycle impact assessment (LCIA) phase?

LCIA identifies and **characterises** the potential effects produced in the environment by the system under study

LCIA aiming to assess the **magnitude** of **contribution** of each elementary flow (i.e. emissions or resource use of a product system) to an **impact** on the environment.

It transforms an elementary flow from the inventory into its potential impacts on the environment.

- How to compare impacts of freshwater contamination with air pollution?
- How to **compare** 1g of methane emitted into the air, with nuclear radiation released to fresh water?



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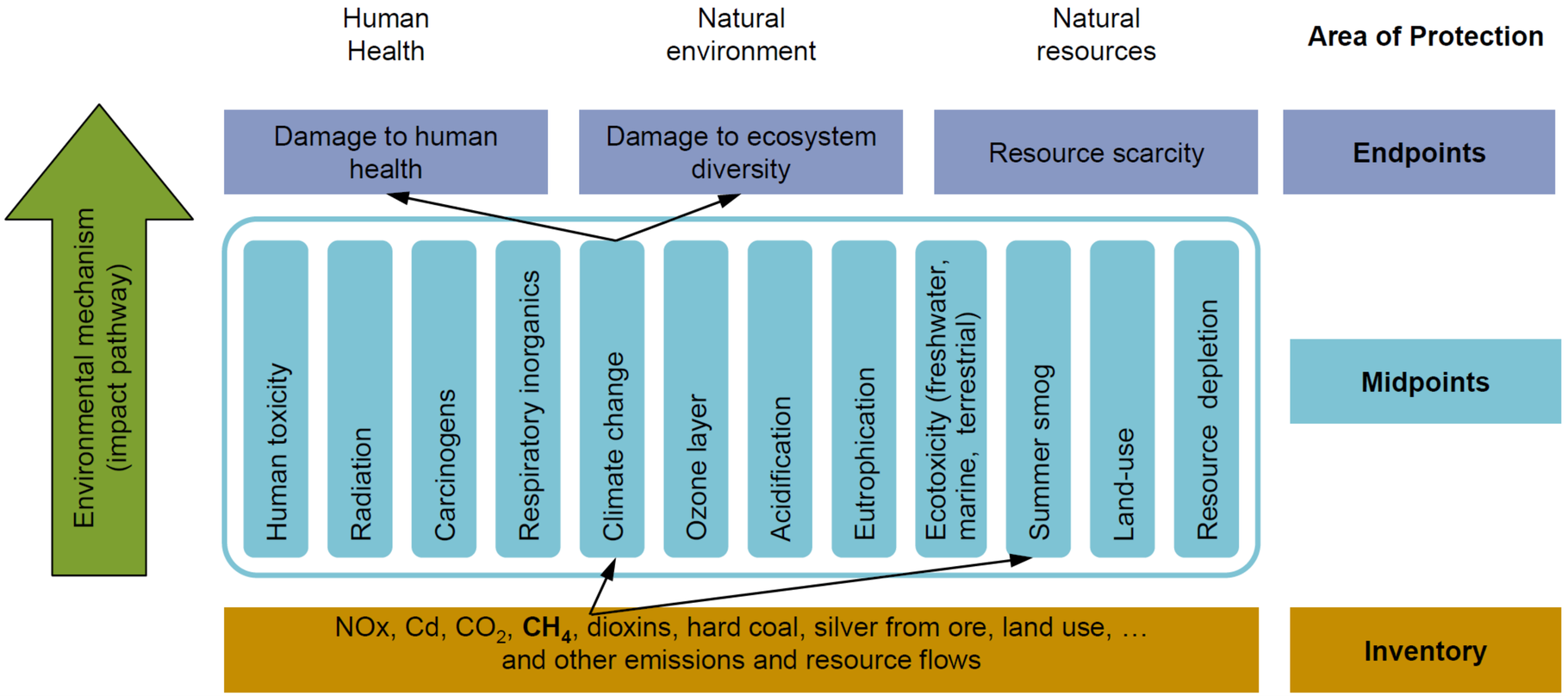
Impact Assessment



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Life Cycle Assessment Interpretation

- Similar step to the traditional **concluding** and **recommending** part of a scientific and technical assessment
- Reduction of the number of quantified data and/or statements of the inventory analysis and/or impact assessment to the **key results** to facilitate the decision-making
- **Robustness** to uncertainties in **data** and **methodology** and gives an acceptable coverage and representation of the preceding phases of **significant environmental issues**
- Evaluation of the inventory analysis and/or impact assessment of a system
- **Conclusions** and **recommendations**
- Interaction with previous LCA phases: if results do not fulfil the requirements defined, the inventory analysis must be improved
- Interpretation is the least developed part of the standard

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Software for performing LCA can help!

Software	Developer
SimaPro	Pré Consultants: www.pre-sustainability.com/simapro
GaBi	Thinkstep: www.gabi-software.com/international/index/
OpenLCA	GreenDelta (open access): www.openlca.org/
Umberto	Ifu Hamburg: www.ifu.com/en/umberto/
Gemis	IINAS (open access): http://iinas.org/gemis.html
GREET	NREL (open access): https://greet.es.anl.gov/


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